Axial Capacity of Piles in Intermediate Geomaterials (IGM)

Meeting Minutes for 1st Quarter 2007 Progress Tele-Conference

Date: May 31, 2007
Time: 09:30-10:30 MST
Participants: MDT: Kent Barnes, Brain Collins, Cameron Kloberdanz, Susan Sillick
MSU: Heather Brooks, Eli Cuelho, Bob Mokwa
Notes by: Bob Mokwa

Minutes

1) An overview was provided by MSU of the primary work tasks to date. These included: 1) literature review, 2) collection and organization of MDT project files, and 3) analyses.
2) MSU requested PDA data for the Swan River (#4228) and Vicinity of White Coyote Road (#1744) projects. Brian and Cameron will send additional data as available. They may also have data on the Corwin Springs project, which encountered a dense gravel deposit that may fall under the IGM classification. Brian and Cameron suspect the PDA data may be in error on some of these projects because of the potentially conflicting results that they observed. They will send the data with a caveat that the results may be in error. Based on further evaluation by the MSU team, these projects may not be suitable for the study because of the unconventional CAPWAP results.
3) Summary Tables 3a and 3b were introduced and briefly discussed. Information from these tables was used to develop plots for assessing any trends or potential correlations in the data. An example of these comparisons is shown in Figure 1.
4) Additional comparisons using normalized data will be further explored. As discussed in the meeting, these may include:
    a) CAPWAP shaft friction versus unconfined compression (q_{uc}),
    b) CAPWAP shaft friction versus length in IGM,
    c) CAPWAP end bearing versus q_{uc},
    d) CAPWAP total capacity versus length in IGM, and
    e) comparisons of CAPWAP shaft friction and end bearing versus values calculated from DRIVEN.
5) Cameron brought up the potential significance of high residual stresses that may exist in many of the IGMs as a result of their heavily overconsolidated condition. MSU will further research the literature to more fully examine this effect in terms of pile resistance.
6) MSU will report on recommendations they uncover in the literature that may lead to improved pile driving predictions. This may involve improvements or modifications to field investigative methods, laboratory tests, or analytical approaches.
7) The meeting participants agreed that a conference call for the 2nd quarter of 2007 would be more useful to the project than a written quarterly report. Sue will coordinate a meeting date and time for sometime in July, after reviewing schedules. Bob will send Sue the MSU team's availability for a teleconference in July.

Table 1. Summary of Projects and Data Categories

Project	CN #	IGM Type	PDA on Project	Bore Logs	Design Report	Driving Logs	PDA Report	DRIVEN Calcs.	GRLWEAP Calcs.	Plans	Hammer Data
***NW Sidey-N**	**1041**	**Siltstone, Coal**	**N**	**Y**	**Y**	**Y**		**Y**		**Y**	**Y**
Milk River- Zurich	1154	Sandstone, Siltstone	N	Y	Y						
*Volberg N &S	1514	Claystone, Siltstone, Sandstone, Coal	N	Y	Y			Y		Y	
*Vic. White Coyote Rd.	1744	Gravel with Silt and Sand	Y	Y	Y		N	Y		Y	
***Nashua- E & W**	**2144**	**Claystone, Shale**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**		**Y**
Colstrip- South	2148	?	N			Y					Y
***Angela- N & S**	**2461**	**Shale**	**N**	**Y**	**Y**	**Y**		**Y**	**Y**		**Y**
***Poplar River- NW**	**2792**	**Claystone**	**N**	**Y**	**Y**	**Y**		**Y**			**Y**
Willow Cr.-NE of Blackfoot	3399	Shale	N	Y				Y		Y	
Cutbank Cr.- NE of Blackfoot	3400	Shale	N	Y	Y						
*N. Fk. Poplar Rv.- 27 km S of Scoby	3417	Claystone, Sandstone	Y	Y	N	Y	Y	Y	Y		Y
Shokin Cr.- S. of Ft. Benton	3887	Shale, OC Clay	N	Y	Y			Y	Y	Y	Y
Little Missouri River-E of Capitol	3988	Shale, Sandstone	N	Y	Y					Y	
Tongue River-Miles City	3989	Dense Gravel, Siltstone, Sandstone	N	Y				Y	Y		Y
Tongue River-Miles City	4174	Dense Sand, Siltstone, sandstone	N	Y				Y	Y		Y
*Swan River-3km SE of Ferndale	4228	Dense Silty Gravel	Y	Y	Y		N	Y	Y		Y
*Bridger Cr. 3 km NE of Bozeman	4230	Dense Silty Sand	Y	Y	N	Y	Y	Y	Y		Y
*Structures- S of Pray	4232	Very Dense Gravel	N	Y				Y	Y	Y	Y
USRS Canal-3km NE of Augusta	4235	Claystone, Siltstone, Sandstone	N	Y	Y	Y					Y
***Big Muddy Cr.-SE of Redstone**	**4239**	**Claystone**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**		**Y**
*Keyser Cr.-2km W of Columbus	4244	Shale, Sandstone	Y	Y	Y		Y	Y	Y	Y	Y
Wolf Cr.- 3km E of Vida	4268	Shale, Coal, Siltstone	N	Y	Y			Y		Y	
***Big Hole River-3km SW of Jackson**	**4539**	**Sandy Gravel**	**N**	**Y**	**Y**	**Y**			**Y**	**Y**	**Y**
Milk river- W of Chinook	5559	OC Clay, Sandstone, Siltstone, Shale	N	Y	Y			Y	Y		Y

Notes for table:

1) "*" Indicates 1st priority projects for analysis (see Table 2).

2) Shaded cells indicate data that is needed for analysis of 1st priority projects.

3) Bolded Projects have enough information to complete full analysis.

3) Y = yes, WTI has information; N = no, WTI does not have PDA information

Table 2. Summary of Analytical Tasks for 1st Priority Projects

Project	CN #	Data Input	Soil Profile Drawing	DRIVEN Analysis	GRLWEAP Analysis	Notes
NW. Sidney-N.	1041	X				DRIVEN 1.0: apparent error in report calculations (evaluating suitability of project for this study)
Volberg-N & S	1514	X				Driving logs, GRLWEAP analysis and Hammer data are still needed for analysis.
Vic. White Coyote Rd.	1744					PDA report, driving logs, GRL WEAP calculations and hammer data is still needed for analysis.
Nashua-E &W	2144	X	X	X	X	
Angela- N & S	2461	X				
N. Fk Poplar	3417	X	X	X	X	
Swan River	4228	X	X			Driving logs and PDA reports are needed when they are completed (project under construction).
Bridger Cr.	4230	X	X	X	X	
Structures S. of Pray	4232					Design report and driving logs are needed in order to complete analysis.
Big Muddy Cr.	4239	X	X	X		
Keyser Cr.	4244	X	X	X		Driving logs are needed to complete analysis.
Big Hole River	4539					DRIVEN calculations are needed for analysis.

Notes:

1) "X" indicates completed task.

Table 3. Project Construction Summaries (a)

Project CN	IGM Type	Pile Location	Bent Station	Pile Type/Size	Total Embedded Length (m)	Pile Length in IGM (m)	q_u (kN)	SPT N-Value* $(N_1)_{60}$
2144	Shale Claystone	Bent 1 Bent 3 Overflow 1	236+01.00 236+47.90 249+74.25	508mm Pipe C 508mm Pipe O 508mm Pipe O	27.48 27.58 25.77	5.19 1.68 4.77	206 Sh 83 Sh 223 Sh	N/A N/A N/A
3417	Claystone Sandstone	Bent 1 Bent 2 Bent 3 Bent 4 Overflow 1 Overflow 2 Overflow 3	5+51.02 5+82.26 6+13.75 6+44.98 7+42.26 7+71.50 8+00.74	406mm Pipe C 762mm Pipe O 762mm Pipe O 406mm Pipe O 406mm Pipe O 610mm Pipe O 406mm Pipe O	12.79 14.36 14.62 12.80 15.22 13.62 16.2	9.74 8.46 8.52 5.79 8.52 9.92 12.20	294 C; 40,479 S 197 C; 367 S 449 C; 545 S 579 C; 523 S 263 C; 2,808 S 328 S; 458 C; 868 C,S,Si 709 C; 19,390 S	N/A N/A N/A N/A N/A N/A N/A
4228	Silty Gravel							
4230	Silty Gravel	Bent 3 Bent 4	35+20.32 35+28.82	610mm Pipe O 406mm Pipe O	8.58 7.23	4.58 3.23	N/A N/A	R* R*
4239	Claystone	Bent 1 Bent 2 Bent 3 Bent 4	11+20.50 11+34.25 11+48.24 11+61.99	H 310x125 406mm Pipe C 406mm Pipe C H 310x125	33.04 31.14 31.92 41.24	4.08 2.18 2.96 12.28	N/A N/A N/A N/A	N/A N/A N/A R*
4244	Shale/ Sandstone	Bent 1 Bent 2	18+06.26 18+35.74	H 310x125 H 310x125	9.24 9.21	1.925 1.895	9,549 Sh; 9,797 S N/A	N/A R*

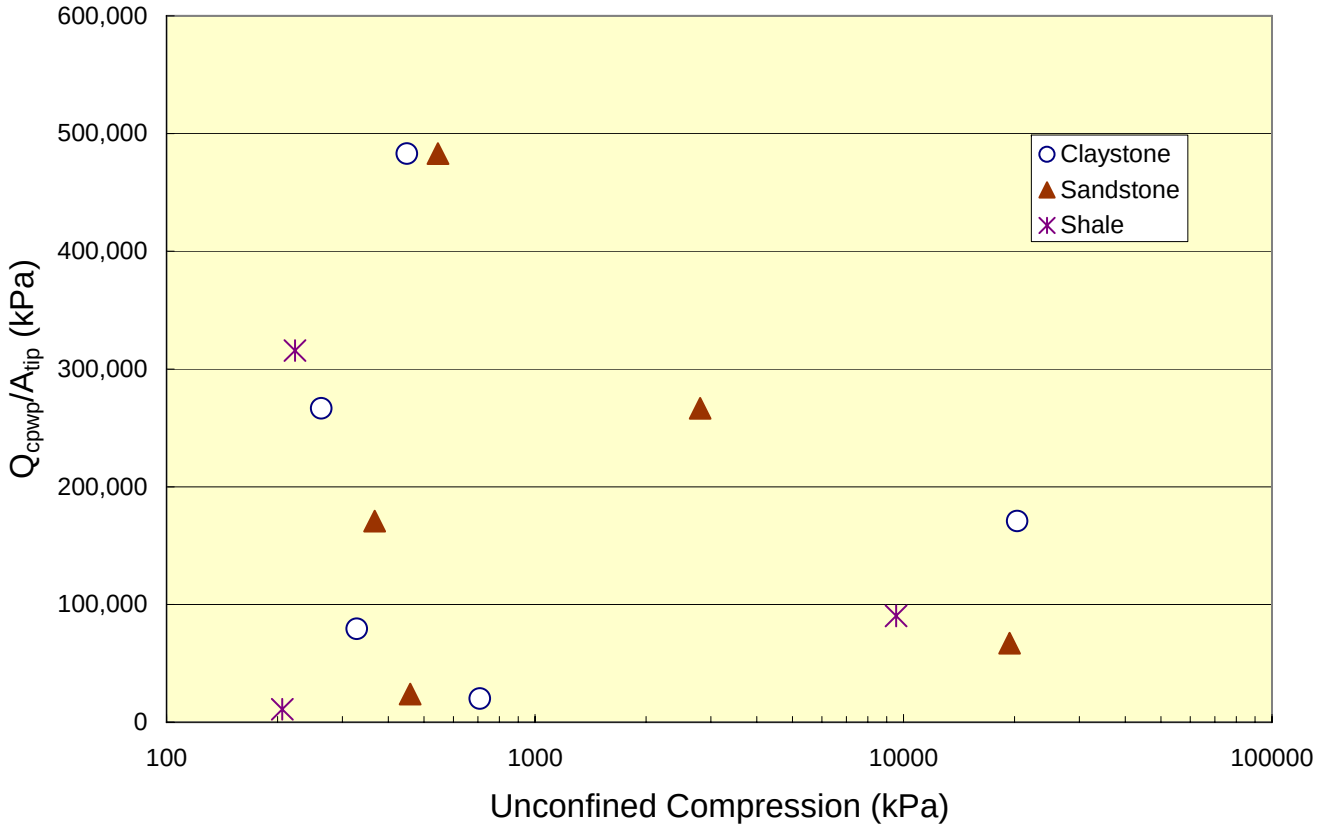
Notes

1) q_u are an average for the IGM at the Bent (abbreviations are below).
   S = Sandstone; Si = Siltstone; C = Claystone; Sh = Shale; SG = Silty Gravel
   Interbedded layers have more than one IGM classification.
2) "*" indicates SPT refusal with greater than 50 blows/ 0.3m.

Table 3. Project Construction Summaries (b)

Project CN	IGM Type	Pile Location	Pile Type and Size	Design Axial Capacity (kN)	Measured Axial Capacity (kN)	Design Pile Length (m)	Actual Pile Length (M)	Comments
2144	Shale/Claystone	Bent 1	508mm Pipe C	2720	2244	29.3	27.48	Refusal
		Bent 3	508mm Pipe O	2825	2388	28.9	27.58	Refusal
		Overflow 1	508mm Pipe O	3150	3160*	26.2	25.77	Refusal
3417	Claystone/Sandstone	Bent 1	406mm Pipe C	1810	1800	12.98	12.79	Refusal
		Bent 2	762mm Pipe O	3870	3845	14.74	14.36	Refusal
		Bent 3	762mm Pipe O	3870	3850	14.74	14.62	Refusal
		Bent 4	406mm Pipe O	1670	2074	12.97	12.80	Refusal
		Overflow 1	406mm Pipe O	1790	2125	16.3	15.22	Refusal
		Overflow 2	610mm Pipe O	2870	3074	15.83	13.62	Refusal
		Overflow 3	406mm Pipe O	1560	2598	17.03	16.2	Refusal
4228	Silty Gravel							
4230	Silty Gravel	Bent 3	610mm Pipe O	2600	3200	8.58	8.58	
		Bent 4	406mm Pipe O	2430	3195	7.23	7.23	
4239	Claystone	Bent 1	H 310x125	2025	2125	30.54	33.04	Running
		Bent 2	406mm Pipe C	2205	2370	32.64	31.14	Refusal
		Bent 3	406mm Pipe C	2205	2404	32.64	31.92	Refusal
		Bent 4	H 310x125	2025	2202	32.64	41.24	Running
4244	Shale/Sandstone	Bent 1	H 310x125	2230	3500	12.22	9.24	Refusal
		Bent 2	H 310x125	2230	2550	12.22	9.21	Refusal

Notes
1) “*” indicates restrike capacity.



Note: Q_{cpwp} = total capacity measured in the field using CAPWAP

Figure 1. Measured Resistance versus Strength Comparison